

EXPLOSIVE HAZARD ASSESSMENT

**FORMER PACIFIC POWDER WORKS
MAYTOWN, WASHINGTON**

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- 1 Site and Surrounding Area Plan
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ATTACHMENTS

Attachment

- A SITE PHOTOGRAPHS
- B EXPRAY TM AND ETK TM INFORMATION
- C MATERIAL SAFETY DATA SHEETS

DISCLAIMER

THIS EHA WAS BASED ON THE ONSITE OBSERVATIONS OF THE INSPECTION TEAM (ED MEEKS – (MWH)) AND MIKE EHLEBRACHT (HART CROWSER, INC.)) AND ON THE DATA AVAILABLE TO MWH AT THE TIME THE ASSESSMENT WAS CONDUCTED. AVAILABLE DATA INCLUDED THE PHASE I ENVIRONMENTAL SITE ASSESSMENT, PHASE II ENVIRONMENTAL SITE ASSESSMENT, THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY SCOPING PLAN, AND DOCUMENTS RELATING TO THE INFORMATION REQUEST TO DYNOL NOBEL INC. FOR CITIFOR SITE REQUESTED BY THE WASHINGTON DEPARTMENT OF ECOLOGY RECEIVED 2/14/04. THE POTENTIAL FOR ENCOUNTERING EXPLOSIVE HAZARDS MAY BE ADVERSELY IMPACTED IF THE IDENTIFIED CONDITIONS CHANGE. ALL HEALTH AND SAFETY RECOMMENDATIONS ARE BASED ON GENERAL INDUSTRY STANDARDS AND SITE SPECIFIC CONDITIONS MAY WARRANT ADDITIONAL OR DIFFERENT PROCEDURES BEYOND THE SCOPE OF THIS EHA. THE INFORMATION CONTAINED WITHIN THE EHA IS SOLELY FOR THE USE OF HERCULES AND MWH. NO UNAUTHORIZED USE OF THE INFORMATION EXCEPT AS DIRECTED BY MWH IS INTENDED.

1.0 INTRODUCTION

Hercules Incorporated (Hercules) retained MWH Americas, Inc. (MWH) to perform an Explosive Hazard Assessment (EHA) for the Former Pacific Powder Site (Site) located in Maytown, Washington (Figure 1). The primary energetic and explosive (E&E) products produced at the Site included nitroglycerin (NG) for the production of dynamite and monoethanolamine nitrate (MEAN) for the production of ammonia nitrate fuel oil (ANFO) and emulsion explosives. Dynamite was produced at the Site from the early 1940's to 1968. MEAN production began in the mid to late 1970's and concluded in 1986. ANFO and emulsion explosives were produced from the late 1960's to 1994. Following cessation of MEAN production, ANFO and emulsion explosives continued to be produced at the site.

The objectives of the EHA are to:

- Inspect the former manufacturing areas of the Site and reconstruct, as best practical, the past manufacturing practices to assist with the proposed remedial investigation/feasibility study (RI/FS).
- Identify E&E constituents, if present, and locate areas where it is possible to encounter E&E constituents.
- Provide recommended procedures for performing the proposed RI/FS in a safe and efficient manner given the potential to encounter E&E constituents as a result of past manufacturing activities.

This EHA is organized as follows:

- Section 1.0 presents the report introduction, objectives, and organization.
- Section 2.0 presents the scope of work.
- Section 3.0 presents the results of the EHA investigation.
- Section 4.0 presents health and safety considerations.
- Section 5.0 presents the conclusions.

2.0 SCOPE OF WORK

This section describes the activities performed as part of the EHA.

2.1 HISTORICAL RECORD REVIEW

The available historic records were reviewed to determine, as best practical, the former operations performed at the Site so that an effective assessment of the potential explosive hazards could be performed. The historical record review consisted of the following:

- Site briefing, including review of limited historical information relating to former Site manufacturing processes. Michael Ehlebracht from Hart Crowser performed the site briefing on November 20, 2003.
- Document review, pertaining to the recent documents summarizing the known historical operations performed at the Site, historical documents pertaining to site cleanup efforts performed by Dyno Nobel, and the 1964 Site map. The documents and map reviewed included:
 1. Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003).
 2. Site Wide Phase II Environmental Site Assessment Former Explosives Plant Maytown, Washington (Hart Crowser, 2003).
 3. Remedial Investigation/Feasibility Study Scoping Plan Former Pacific Powder Site (Hart Crowser, 2003).
 4. June 18, 1993 Memorandum Discussing Explosive Materials Discovered in the Alleged Burial Site (ABS) Landfill.
 5. September 7, and 8, 1993 Memoranda Discussing Hercules Titan 25 G Boosters Discovered in the MEAN Plant Sump.
 6. October 7, 1993 Memorandum Discussing Burned Blasting Cap Area.
 7. October 19, 1993 Memorandum Discussing Thermal Decontamination for NG Buildings.
 8. February 7, 1994 Memorandum Describing Magazine Thermal Decontamination.
 9. 1964 Site Map.

10. Derick Pyle (former Hercules employee) Notes Concerning Operations Performed at the Site.

- Review of available aerial photographs (1960, 1965, 1977, and 1997) to evaluate the general condition of the Site and help reconstruct previous operations.
- Collection and review of pertinent associated information to provide guidance on expected Site operations and former structure construction. The following information was reviewed:
 1. Hercules Incorporated Kenvil Works – Operation and Maintenance of Nitroglycerin Buggies.
 2. Hercules Incorporated Kenvil Works – Preparation and Handling of Nitroglycerin Slums.
 3. Hercules Incorporated Kenvil Works – Operation of Nitroglycerin Store House.
 4. Hercules Incorporated Kenvil Works – Clean Up of Liquid Explosive Spills.
 5. Hercules Powder Company – Continuous Nitroglycerin Facilities Electrical, Power, and Lighting Ground Floor Plan.
 6. Hercules Powder Company – Continuous Nitroglycerin Facilities Engineering Flow Diagram.
 7. Hercules Powder Company – Continuous Nitroglycerin Facilities Equipment Arrangement.
 8. Hercules Powder Company – Catch Tank House Continuous Nitroglycerin Facilities.
 9. Pacific Powder Site – Emulsion Operation Checklist.
 10. Pacific Powder Site – Monoethanolamine Nitrate Operation Checklist.

2.2 SITE INSPECTION

Ed Meeks (MWH) and Mike Ehlebracht (Hart Crowser) conducted the site inspection on November 20, 2003. The site inspection focused primarily on the areas known to be associated with E&E manufacture, handling, and storage. The site inspection was divided into the following four discrete areas (Figure 2):

- Dynamite Manufacturing Area (consisting of the Old Nitrator Area, New Nitrator Area, and related structures)
- Powder Plant Area
- MEAN Plant Area
- Associated features (includes storage areas, Seismic Pond, Drum Burial Area, and burn pits)

Each of the four areas was traversed on foot as thoroughly as practical, or viewed from the closest vantage point depending on limitations due to vegetation, to identify currently visible indicators for E&E constituents. Specifically, the site inspection evaluated the Site for the following features:

- Former facility structures (i.e. pipes, foundations, barricades, etc.)
- Physical presence of E&E constituents
- Associated materials (drums, cans, etc.)
- Migration pathways (stream channels, flood plain, etc.)
- Likely deposition areas (demolition piles, disturbed areas, containment structures)

Photographs taken during the site inspection are included in Attachment A.

3.0 RESULTS

The following sections describe the results of the Maytown EHA.

3.1 HISTORICAL RECORD REVIEW

This section presents the results of the historical record review and includes the following subsections:

1. Document Review
2. Aerial Photographs Review
3. Manufacturing Processes

3.1.1 Document Review

The following information was identified during the document review that was determined to be pertinent for the manufacture, handling, and storage of E&E materials at the Site:

Dynamite Production History

- NG was manufactured at the Site for the production of dynamite from the early 1940's to 1968 (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).
- Waste acid (sour water) was discharged to an unlined pond (Acid Pond) adjacent to the old nitrator (Figure 2). Sour water can contain up to 500 parts per million dissolved NG. The exact operational history of this process is unknown but may extend from the early 1940's to 1967. In 1967, Hercules completed construction of a nitric acid recovery tower eliminating acid discharges to the pond (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).
- Nitro Cotton, i.e. nitrocellulose (NC), was used as an absorbent for the manufacture of dynamite. The operational date of NC usage is not known but may extend from the early 1940's to 1968. A Nitro Cotton Store House is identified on the 1964 Site Map.
- DNT was identified as an ingredient used for the production of dynamite at the Site. The exact history of DNT usage is not known but may extend from the early 1940's to 1968 (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).

- 2,4,6-trinitrotoluene (TNT) and ammonia perchlorate (AP) were used as ingredients in the manufacture of dynamite. The exact history of TNT and AP usage is not known. TNT usage may extend from the early 1940's to 1968.
- NG was identified in 1964 on surface soils adjacent to the NG storehouse (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)). The term NG Storehouse is commonly used to denote NG neutralizer operations (i.e. Neutralizer House depicted on Figure 2).
- Additional dynamite products (D-Gel and Tritex) were produced at the Site from 1966 to 1968. D-Gel is a type of dynamite that uses dinitrotoluene (DNT) as a desensitizing agent (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).
- Hercules ceased using the batch nitrator acquired from Pacific Powder and constructed a new continuous nitrator in early 1968 (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).
- A burn pit (PP1 Burn Pit) of unknown operational history was used by Pacific Powder (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)) to destroy scrap explosives and thermally decontaminate drums/scrap metal prior to removal from the Site (Figure 2).
- Hercules constructed a burning pit (1960's Era Hercules Burn Pit) upon taking ownership of the Site (Figure 2) (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).
- Hercules thermally decontaminated and demolished the dynamite production areas presumably in 1968, or soon thereafter (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)).
- Dyno Nobel thermally decontaminated former dynamite magazines prior to February 7, 1994.
- The removal of foundations and potential subsurface process drain lines is not mentioned in the reviewed documentation.

ANFO and Emulsion Explosives Production History

- ANFO and emulsion explosives were produced at the Site from the late 1960's to 1994 (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)). Manufacturing operations were believed to have been primarily conducted in the main plant building and MEAN plant (Figure 2).
- The MEAN plant was in operation from the mid 1970's to 1986. MEAN produced was used as an ingredient in the ANFO and emulsion explosives manufacture.

- The main plant building was presumably operational until 1994.
- Presumably Pacific Powder Pipe & Supply, Inc. (PPP&S) constructed two burn pits (1970's Era Fireworks Burn Pits) after leasing the property from Hercules in 1970 (Figure 2).
- Presumably ANFO and emulsion explosives were discovered in the Alleged Burial Site (ABS) Landfill in June 1993. The June 18, 1993 letter describing the event did not identify the explosives but did mention a softball sized clump of nitrate crystals. A dynamite punch press was identified in the material so it is possible that dynamite products were also disposed of at this location. A recent interview with Ken Dunkin, an APPCO employee involved with the ABS cleanup, indicated that excavation and removal of debris and E&E materials was performed until no further evidence of contamination was observed along the excavation boundaries.
- 103 Hercules Titan 25 G boosters were found in the MEAN plant sump according to Dyno's September 1993 memorandum. Employees believe 99% to 100% of boosters were found and identified. The boosters were removed and presumably destroyed.

Miscellaneous Site Operations

- A blasting cap burning area (Farm House Burn Pit) was found adjacent to an old farmhouse (Figure 2). The exact location of the blasting cap burning area is not depicted on any historic maps but a hand drawing in Dyno's October 7, 1993 memorandum attempts to locate the area. Some small fragments of detonation cord and approximately 100 pounds of burnt blasting cap wire was removed.

3.1.2 Aerial Photographs Review

The following information was identified as part of the aerial photograph review that was determined to be pertinent for the manufacture, handling, and storage of E&E materials at the Site:

- Very large earthen barricades are visible surrounding the high explosive hazard manufacturing structures (Nitrator House and Neutralizer House) in the 1960 and 1965 aerial photographs. The barricades appear to extend above the top of the structures. The structure foundations may have been at a significantly lower level than the current top of the existing mounds that were the former barricades. This is typical construction for high explosive hazard manufacturing structures.

- The NG gutter used to transfer NG from the Nitrator to the Neutralizer House is visible in the 1965 aerial photograph. An earthen barricade may also protect the NG gutter but it cannot be fully determined by the photograph.
- The MEAN Plant structure is evident in the 1977 aerial photograph. The exact date of construction is not known.

3.1.3 Manufacturing Processes

The following is a description of the manufacturing processes historically performed or similar to those performed at the Site.

NG Manufacturing

The following information was collected and reviewed from the archives of the former Hercules Kenvil Works Facility located in Kenvil, New Jersey. The primary objective of reviewing this information was to understand the operational history and general construction details of NG manufacturing processes performed by Hercules. In the event former manufacturing foundations or equipment are discovered, this information may prove invaluable to those performing site activities.

It is likely some variations exist between exact facility construction and standard operating procedures (SOPs) between companies or facilities involved with NG production. However, the bulk of the material will be very similar, as the manufacture of NG requires adherence to industry standard safety requirements.

The following SOPs were reviewed to understand typical procedures that would have been utilized during the period Hercules owned and operated the Site (1964 to 1968):

- Hercules Incorporated Kenvil Works – Operation and Maintenance of Nitroglycerin Buggies.
- Hercules Incorporated Kenvil Works – Preparation and Handling of Nitroglycerin Slums.
- Hercules Incorporated Kenvil Works – Operation of Nitroglycerin Store House.
- Hercules Incorporated Kenvil Works – Clean Up of Liquid Explosive Spills.

The following figures were reviewed to understand typical Hercules construction standards for continuous NG manufacturing facilities. Some variations do exist from facility to facility but the majority of the operations are standardized. The former batch NG manufacturing process employed by the Pacific Powder Company may be somewhat differently configured but the majority of the equipment will be very similar. The following figures were reviewed:

- Hercules Powder Company – Continuous Nitroglycerin Facilities Electrical, Power, and Lighting Ground Floor Plan.
- Hercules Powder Company – Continuous Nitroglycerin Facilities Engineering Flow Diagram.
- Hercules Powder Company – Continuous Nitroglycerin Facilities Equipment Arrangement.
- Hercules Powder Company – Catch Tank House Continuous Nitroglycerin Facilities.

Emulsion Explosives and MEAN Production

Dyno Nobel provided the following information to the Washington Department of Ecology (Ecology). The following checklists provide detailed information to the procedures used to manufacture emulsion explosives and MEAN at the Site:

- Pacific Powder Site – Emulsion Operation Checklist.
- Pacific Powder Site – MEAN Operation Checklist.

No process information could be located describing the ANFO manufacturing procedure. However, ANFO and emulsion explosives are similar compounds with ANFO generally in granular state and emulsion explosives in a viscous liquid state. No figures could be located describing facility construction and equipment layout details.

3.2 SITE INSPECTION

This section describes the results of the site inspection. The weather conditions encountered during the site inspection were less than ideal. Approximately an inch of snow had fallen as the site inspection was conducted. In addition to the adverse weather conditions, shipment of

the EXPRAY explosive test kit was delayed and was not available for the site inspection. Scotch broom has greatly proliferated over major portions of the former operational areas further restricting visual inspections. The following subsections are presented in this section:

- Dynamite Manufacturing Area
- Powder Plant Area
- MEAN Plant Area
- Associated Features (Storage Areas, Seismic Pond, Drum Burial Area, Burn Pits)

3.2.1 Dynamite Manufacturing Area

The Dynamite Manufacturing Area for discussion in this EHA is comprised of the former operations involved with the manufacture of NG (Old Nitrator Area and New Nitrator Area) and the mixing and packing of the dynamite products produced at the Site. Nearly all evidence of this former operation is either no longer visible or has been removed. EHA efforts within the Dynamite Manufacturing Area focused primarily on the former operations that have the highest possibility of containing residual E&E constituents, which include; New and Old Nitrators, Acid Pond, Neutralizer, NG Storehouse, and Mix House. The remainder of the dynamite manufacturing area was inspected as thoroughly as practical given the conditions to determine if any currently unknown historical operations existed at the Site. The following is a description the site inspection of the Dynamite Manufacturing Area:

Old Nitrator and Associated Quonset Hut

The area of the Old Nitrator House (Attachment A, Photograph #1) is forested and no evidence of the former structure is evident (Figure 2). The former earthen barricade remains and has been leveled off at the top. The ground surface does not feel solid and several small sinkholes (less than 1-foot in diameter) were identified. The depth of the sinkholes could not be determined during the site inspection. It is possible that following thermal decontamination of the nitrator the earthen barricade was pushed over the foundation. There were no visual indications of E&E constituents present.

The associated Quonset Hut (Attachment A, Photograph #2) located adjacent to the old nitrator remains intact (Figure 2). All associated equipment has been removed leaving only

the outer shell of the structure. Based on the location and the construction, it is likely the Quonset Hut was the motor house used to support the nitrator. The 1964 Site Map identifies the motor house. There were no visual indications of E&E constituents present.

Acid Pond and Associated Operations

The operations associated with the Acid Pond include; Spent Acid Catch House, unknown remnant foundation, and a vitreous clay pipe. The Acid Pond is located adjacent to the Old Nitrator (Figure 2). The following is a description of each operation:

The former Acid Pond (Attachment A, Photograph #3) is overgrown with scotch broom and trees. The area of the Acid Pond appears to have been reworked historically, possibly during site decommissioning or logging activities. There were no visual indications of E&E constituents present at the ground surface. The scope of this EHA did not include an inspection of the subsurface to evaluate sediment within the former pond.

The Spent Acid Catch House (Attachment A, Photograph #3 and #4) is located at the boundary of the former Acid Pond. Everything of the former structure has been removed but the concrete foundation. A small pile of quartz rocks (Attachment A, Photograph #4) was identified on the foundation. The exact usage of the quartz is unknown, however, it is often found in acid recovery processing operations and is likely utilized due to its resistance to acids. There were no visual indications of E&E constituents present.

A remnant foundation (Attachment A, Photograph #5) was found immediately adjacent to the Acid Pond. The use of the foundation is not known but it is expected to be associated with the form NG Gutter used to convey NG to the Neutralizer House. There were no visual indications of E&E constituents present.

A vitreous clay pipe (Attachment A, Photograph #6) was identified within the boundary of the Acid Pond. This type of pipe is commonly used as process drain pipes at E&E manufacturing areas. The use of the drainpipe is not known but the potential exists that it represents a process drain to the Acid Pond. It could not be determined if the pipe was intact or if it represents debris from decommissioning activities. There were no visual indications of E&E constituents present.

Neutralizer House

The area of the Old Neutralizer (Attachment A, Photograph #7) is forested and no evidence of the former structure is evident (Figure 2). The former earthen barricade remains and has been leveled off at the top. There was no visual evidence of the former NG Gutter that conveyed NG from the Old Nitrator to the Neutralizer. It is possible that following thermal decontamination of the neutralizer the earthen barricade was pushed over the foundation. There were no visual indications of E&E constituents present.

Mix House

The area of the Mix House (Attachment A, Photograph #8) is forested and no evidence of the former structure is evident (Figure 2). The former earthen barricade remains and has been leveled off at the top. There is no remaining evidence of the former NG buggy paths that were used to transport NG from the Neutralizer to the Mix House. It is possible that, following thermal decontamination of the Mix House, the earthen barricade was pushed over the foundation. There were no visual indications of E&E constituents present.

Note: Dynamite Mix Houses generally had associated DNT Melt Houses. The DNT Melt House would have been located in close proximity to the Mix House so that melted DNT could be quickly transported to the mixer and added to the process before returning to the solid state. There was no evidence of the DNT Melt House identified. However, a former employee placed it 50 to 100-feet south of the Mix House (Phase I Environmental Site Assessment Citifor Maytown Property (Hart Crowser, 2003)). Another facility operated by Hercules (Kenvil Powder Works) combined a NG buggy shelter with a DNT Melt House and it is believed that the NG Buggy Shelter identified on the 1964 Site Map represents the DNT Melt House identified by the former employee.

DNT is not explosive under most conditions but is worth mentioning, as it is often an element of environmental investigation and has been identified in samples collected at the Drum Burial Area (Figure 2).

New Nitrator

The area of the New Nitrator House (Attachment A, Photograph #9, #10, and #11) is heavily overgrown with scotch broom and the only evidence of the former structure is a pile of concrete rubble (1964 Site Map). No evidence of the former earthen barricade, likely present during the operation period, could be identified. An area of disturbed ground and some small steel pipes and wire are also present. The amount of debris present is not believed to be sufficient to account for the entire former New Nitrator. There were no visual indications of E&E constituents present.

NG Storehouse

The area of the NG Storehouse (Attachment A, Photograph #12) is heavily overgrown with scotch broom and there is no evidence of the former structure (1964 Site Map). The NG Storehouse is associated with the New Nitrator and would have functioned similarly to the Neutralizer House. No evidence of the former earthen barricade, likely present during the operation period, could be identified. There were no visual indications of E&E constituents present.

Dynamite House #1/#2 and Gelatin House #1/#2

The Dynamite Houses #1/#2 and the Gelatin House #1/#2 (Figure 2 and 1964 Site Map) were completely overgrown with scotch broom and not accessible.

Acid and Glycol Tank Cradles

The scotch broom was removed from the former acid and glycol tank cradles (Attachment A, Photograph #13 and #14) allowing inspection (Figure 2). The acid and glycol tanks were used to support the NG manufacturing process. The cradles remain intact but all former tanks and associated above ground piping has been removed. There were no visual indications of E&E constituents present.

3.2.2 Powder Plant Area

The Powder Plant Area (Attachment A, Photographs #15, #16, and #17) is comprised of the former operations involved with the manufacture of ANFO and emulsion explosives, including the possible addition of MEAN into the final product (Figure 2). Additional various Site support operations were conducted in this area (i.e. maintenance shops). The Powder Plant Area currently contains approximately 10 primary structures, several small support structures, and above ground storage tank (AST) containments. In addition to the currently identified structures, one additional unidentified historic foundation was located and may be present on the 1964 Site Map.

The primary focus of the EHA was the main plant structure (identified as Building 9 on Figure 2) since it was the operation involved with the manufacture and handling of E&E materials (Photograph #15). All manufacturing equipment has been removed from the structure. There were no visual indications of E&E constituents present but an evaluation of the surfaces above 6-feet in height could not be performed.

The sodium perchlorate and acid tank containment area (Photograph #16) was found to be in good condition and there were no visual indications of E&E constituents present. The containment area held rainwater and there were no indications of breaches within the concrete.

The unidentified historic foundation (Photograph #17) was overgrown with trees. There were no visual indications of E&E constituents present.

3.2.3 Monoethanolamine Nitrate (MEAN) Manufacturing Area

The MEAN Plant Area (Attachment A, Photographs #18) was used to manufacture MEAN and served as a mixing plant for ANFO (Figure 2). The area of the MEAN Plant Area is completely overgrown with scotch broom and could not be effectively traversed. No indications of the former operation could be identified.

3.2.4 Associated Features

The associated features are, for discussion purposes in this EHA, the historic site operational features that supported the various E&E manufacturing processes with the potential to encounter E&E materials. The associated features include; Seismic Pond, Drum Burial Area, Alleged Burial Site (ABS) Landfill, and miscellaneous E&E storage facilities. The following is a description of the associated features:

Seismic Pond

The Seismic Pond (Attachment A, Photograph #19) has been described by Ken Dunkin of APPCO as a small semi-circular depression located at the edge of a wetland area (Figure 2). The area of the Seismic Pond is currently completely overgrown with vegetation and the exact dimensions could not be determined. The primary function of this type of operation was to test and evaluate the E&E products manufactured at the Site. Based on the surrounding topography, vegetation growth, and discussions with Ken Dunkin, the Seismic Pond appears to have been shallow. There were no visual indications of E&E constituents present.

Drum Burial Area (Pacific Powder Burn Area)

The Drum Burial Area (Attachment A, Photographs #20, #21, and #22) is heavily overgrown with scotch broom and displays the effects of the remnant drum removal activities (Figure 2). The former Pacific Powder Burn Pit is located within the area of the Drum Burial Area. Multiple excavation trenches and soil stockpiles are present. There were no visual indications of E&E constituents present.

ABS Landfill

The ABS Landfill is heavily overgrown with scotch broom (Figure 2). At the time of the site inspection little information was known of the ABS Landfill and efforts were not focused towards it. However, recently received information indicates E&E materials were found and removed during excavations performed in this area by Dyno Nobel.

E&E Storage Areas

The Site has historically operated 4 magazines to store dynamite and it appears in recent years utilized two additional E&E storage facilities (Attachment A, Photographs #23 through #28). Magazines 1, 3, 4, Well PP#6 Shed , and Building 9203 are located on Figure 2. The magazines have been completely removed and only the earthen barricade remains at Magazines 3 (Photograph #24) and 4 (Photograph #25 and #26). The earthen barricade has been removed from Magazine 1. The two recent E&E storage facilities (Well PP#6 and Building 9203) are still standing. These structures possess the characteristic Bureau of Alcohol Tobacco and Firearms (BATF) required lock protection to provide additional security. There were no visual indications of E&E constituents present. The Magazine 2 location was not inspected as part of the EHA.

4.0 HEALTH AND SAFETY CONSIDERATIONS

Health and safety is a paramount issue when working in areas that have the potential to contain E&E constituents. The majority of the health and safety issues can be effectively addressed with adequate awareness training, appropriate procedures, and detailed attention to safety by field personnel. The most important necessary information for determining health and safety considerations are the following:

- What E&E constituents did the former operation manufacture/utilize
- Is there a potential to encounter former process equipment and manufacturing operations
- Can the E&E constituents be identified in the field
- What training is necessary for field personnel
- What special equipment is necessary
- What task specific plans are required
- What field procedures should be used

It is very important to note that as new information is collected it must be evaluated to determine if alterations are necessary to ensure the safety of field personnel. The following sections address the above listed bullet items.

4.1 E&E CONSTITUENTS MANUFACTURED OR UTILIZED

The E&E constituents manufactured or used at the facility include NC, NG, TNT, AP, sodium perchlorate, MEAN, and ANFO. The NG, NC, AP, and TNT were used to produce dynamite products. The MEAN and ANFO may have been sold as final products but were likely also used to produce various forms of ANFO and emulsion explosives. Sodium perchlorate was used as an ingredient for the manufacture of ANFO and emulsion explosives.

Dynamite, ANFO, and emulsion explosives have a wide variety of products marketed under numerous trade names. Commercial dynamite (including gelatin dynamite) is commonly rated in percent strength NG and can range from 40% to 80% NG content. ANFO and

emulsion explosives also have a wide range of formulations marketed under various trade names. The primary constituents in most emulsion explosives are ammonia nitrate (AN), fuel oil, powdered metal, and at this site MEAN and sodium perchlorate.

Blasting caps have been used at the Site. They are small cylindrical objects commonly attached to wires. They contain small, very sensitive charges of primary explosives enclosed in a watertight container.

Boosters, small charges of sensitive E&E materials intended to detonate large charges, though not believed to have been manufactured at the Site have been found in the MEAN Plant sump. It is not known why they are present at the Site but the potential to encounter additional boosters is a potential hazard.

DNT was reported to have been used at the Site. DNT was commonly used historically in the manufacture of dynamite. While DNT is not explosive under most conditions, it is often encountered at E&E manufacturing sites and warrants identification.

4.2 POTENTIAL TO ENCOUNTER FORMER PROCESS EQUIPMENT AND MANUFACTURING OPERATIONS

The majority of the former process equipment and operations appear to have been removed from the Site. Former operations include facilities directly involved with the manufacture of E&E materials, including the following:

- Process Manufacturing Structures
- Process Manufacturing Foundations
- Process Manufacturing Drains
- Process Waste Disposal Areas (ponds, lagoon, ditches, landfills)

The potential may exist that former manufacturing foundations and process drains remain buried, and possibly intact. The former manufacturing foundations and process drains are commonly the most likely locations to encounter E&E constituents. The former operations with the highest potential to encounter E&E constituents are the following:

- New Nitrator

- Old Nitrator
- Neutralizer House
- NG Storehouse
- Acid Pond
- Mix House
- Nitro Cotton House
- Dynamite Houses #1 and #2
- Gelatin Houses #1 and #2
- Mean Plant
- Main Plant

Packing, storage and support operations have the potential to contain E&E constituents but the probability is significantly lower.

Note: Former manufacturing foundations and process drains have the potential to contain confined E&E constituents. Extreme care must be taken if confined explosives are encountered or suspected as detonations can occur.

4.3 FIELD IDENTIFICATION OF E&E CONSTITUENTS

Field identification of E&E constituents is an extremely important capability during intrusive site activities, especially in close vicinity to former process equipment and manufacturing operations. All field personnel should be instructed in the field identification process prior to conducting intrusive site activities. Field identification can be accomplished by the following two means:

- Physical Appearance
- Colorimetric Test Kits

4.3.1 Physical Appearance

Physical appearance is often the most difficult means of field identifying E&E constituents. It generally requires significant experience with the E&E constituent in question. The difficulty of identifying E&E constituents by physical appearance is that the constituent can change appearances in various states of manufacture and interaction with the environment.

The following is a general description of the physical appearance of the E&E constituents that were used or manufactured at the Site:

- NC – White fibrous material. Depending on the size of the fibers NC can range in appearance from paste like to cottony in texture.
- NG – Viscous oily liquid. NG can range in appearance from clear to milky white.
- TNT – Brown, tan to red crystalline material. Depending on the manufacture crystals can be very small to approximately ¼-inch in length. TNT readily degrades in sunlight and when degraded can appear as a molten black material.
- AP/Sodium Perchlorate – White crystalline material. Crystals are generally very small and can appear like a powder.
- MEAN – Further evaluation of the manufacturing process is necessary to describe the physical appearance of MEAN.
- ANFO – Pale brown to dark brown granular material. Granules can be of various sizes depending on manufacturing process.
- Blasting Caps – Small aluminum cased primary explosive, most commonly measuring approximately ¼-inch in diameter and 2-inches in length, with two thin wires extending from aluminum case. Historically, the case was constructed of lead.
- Booster - Larger than a blasting cap and designed to initiate large explosive charges. Can range in shape from 12-ounce beverage cans to similar but larger blasting caps.

4.3.2 Colorimetric Test Kits

Colorimetric test kits are often the best way to field identify E&E constituents. Colorimetric test kits are readily available and do not require extensive training to gain competency. Currently there are two widely available colorimetric test kits available; ETK TM and EXPRAY TM (Attachment B presents information on ETK TM and EXPRAY TM). Both test kits are similar and cost about \$3 dollars per test. The following is a description of the EXPRAY TM procedure:

- The EX-PRAY® test kit is an aerosol-based technique that utilizes a patented paper and colorimetric reaction to identify E&E constituents present down to a level of 20 nanograms. This kit can differentiate between polynitro-aromatics

(TNT, picric acid, etc.), nitrate esters (nitroglycerin, NC, etc.), and Nitramines (cyclotrimethylenetrinitramine (RDX), cyclotetramethylenetetranitramine (HMX), etc.). The EX-PRAY® kit, however, does not provide precise E&E constituent differentiation or concentration data; rather, it is designed to determine if E&E constituent classes are present and the relative range of concentration. They do not provide specific concentrations but are very effective for identifying if an E&E constituent is present and if it is at high concentrations exceeding 10% concentration.

Note: Immunoassay test kits are available that can provide ranges of concentrations for select E&E constituents. They are slower and more expensive than colorimetric test kits and are best used for delineation efforts once the constituent present is known.

4.4 TRAINING FOR FIELD PERSONNEL

A hazard communication (HAZCOM) program discussing site related E&E constituents should be established prior to initiation of field investigations. The HAZCOM program should discuss the chemical and physical hazard and general appearance of the E&E constituents that could be encountered at the Site. The following constituents should be included at a minimum:

- Dynamite (including gelatin dynamite)
- NC
- NG
- TNT
- AP/Sodium Perchlorate
- ANFO
- MEAN/Monoethanolamine
- Emulsion Explosives
- Blasting Caps
- Boosters

The HAZCOM program should also give a general description of explosives in the event non-Site related E&E constituents are encountered. Material safety data sheets (MSDS) are an excellent source of information for developing a site-specific HAZCOM program (Attachment C contains MSDS' for the above mentioned items).

4.5 SPECIAL EQUIPMENT

Special equipment is often necessary to safely conduct intrusive site activities in close proximity to former process equipment and manufacturing operations. The following is a minimum recommendation for site investigation equipment beyond the conventional level of personal protective equipment (PPE) for specific tasks performed at the site:

- Excavating equipment should be equipped with a polycarbonate (i.e. Lexan ®) blast shield no less than 1-inch thick when operating activities in close proximity to former process equipment and manufacturing operations. The blast shield should cover the front window of the equipment selected for use.
- Hand sampling equipment should be constructed of stainless steel, as it possesses non-sparking properties.
- Hand excavation equipment should be constructed of non-sparking materials. The most common non-sparking equipment is constructed of a nickel-copper alloy.
- Field personnel should wear Nomex TM fire retardant coveralls.

Note: This is a general recommended list of special equipment to be employed. Site conditions must be monitored closely by field personnel and any change of conditions may warrant additional safety precautions.

4.6 TASK SPECIFIC PLANS

Task specific plans are recommended when conducting intrusive activities in close proximity to former process equipment and manufacturing operations. Often it is best to define all necessary safety procedures and required equipment into short task specific plans specific to the area in question and based upon the input of all personnel involved. They can be attachments to the site-wide health and safety plan or this EHA. The following is a minimum list of task specific plans:

- Excavation in close proximity to former process equipment, manufacturing operations, and testing/disposal areas.
- Sample collection in close proximity to former process equipment, manufacturing, and testing/disposal areas.

4.7 GENERAL RECOMMENDED FIELD PROCEDURES

The following sections describe general recommended field procedures to be used at sites that formerly manufactured E&E constituents. The following topics will be discussed:

- Conducting Test Pits
- Collecting Soil Samples
- Clearing Well Installation Locations
- Shipping Samples
- Encountering Deposits of E&E Constituents
- Exposing and Removing Former Process Foundations and Process Drainpipes
- Performing Sympathetic Detonation Program

4.7.1 Conducting Test Pits

Test pits are one of the safest methods for physically evaluating the subsurface in areas potentially containing E&E constituents or the potential exists to encounter former manufacturing foundations and process drains. Field personnel are removed from close proximity to the excavation and the blast shield protects the equipment operator. Test pits should be advanced at intervals of 0.5 to 1.0-feet and evaluated by personnel trained to identify E&E constituents. The evaluation should include the use of the colorimetric test kit if the evaluator identifies potential E&E constituents. The advancement and evaluation should continue until the desired depth is achieved. In the event moderate to high concentrations of E&E materials are encountered the test pit should be halted. A thorough evaluation of the E&E constituents present and a determination if it is safe to continue must be conducted prior to continuing test pit activities.

4.7.2 Collecting Soil Samples

The safest method to collect soil samples when the test pit method is not warranted or not available is to use a non-sparking shovel (i.e. nickel/copper alloy). The shovel is slowly pushed into the subsurface under a uniform pressure until the desired depth is reached or refusal is encountered. Under no circumstances should the shovel be driven or hammered. Upon extraction of the shovel the collected sample should be evaluated with the colorimetric

test kit, if appropriate. In the event moderate to high concentrations of E&E materials are encountered, the boring should be halted. A thorough evaluation of the E&E constituents present and a determination if it is safe to continue must be conducted prior to resuming the sampling activity.

4.7.3 Clearing Monitoring Well Installation Locations

When installing monitoring wells in close proximity to former manufacturing or disposal areas, it is recommended to verify the shallow subsurface is free of E&E constituents prior to initiating drilling activities. The most effective method to clear a monitoring well location is to advance a test pit several feet into the native sediment. If E&E constituents are identified at more than trace concentrations, the well installation should be relocated to an area free of E&E constituents.

4.7.4 Shipping Samples

All samples collected from former E&E manufacturing facilities should be screened with a colorimetric test kit prior to shipment to the laboratory. A small portion of the sample should be removed so that adhesive present on the test kit paper is not exposed to the sample, and tested with the colorimetric test kit. If the colorimetric test kit detects only trace E&E constituents or less, the sample is safe to be shipped to the laboratory. If the colorimetric test kit detects moderate to high concentrations of E&E constituents, the sample should be diluted with clean material until only trace E&E constituents are detected before shipment to the laboratory. This is performed only to positively identify the E&E constituents present and establish an approximate concentration. The results of this sample are intended only to make safety decisions and not be used for environmental decision making. In the event dilution of the sample is not possible or permissible, the sample should be hand carried to a local laboratory for analysis and the laboratory notified prior to receipt of the sample.

Note: DNT is not explosive under most conditions and samples can safely be shipped at moderate to high concentrations.

4.7.5 Encountering Deposits of E&E Constituents

The possibility exists that deposits of E&E constituents can be encountered while performing environmental investigations at former E&E manufacturing facilities. A deposit is generally defined as either a layer or chunk of E&E constituent that is visibly identifiable from the native sediments. In the event a deposit of E&E constituents is encountered, all heavy equipment operations should cease. If safe, the field crew should identify the E&E constituent and determine the potential concentration, as best possible, using a colorimetric test kit. The area should be marked and access restricted to personnel trained to handle E&E constituents. Sufficient plans should then be developed to address the collection/disposal/destruction of the E&E constituent prior to excavation.

Note: No E&E material should be accumulated until all Bureau of Alcohol, Firearms, and Tobacco (BATF) regulations have been satisfied.

4.7.6 Exposing and Removing Former Process Foundations and Process Drain Pipe

The presence of former NG process foundations and potential subsurface process drainpipes is not known at this time. However, former manufacturing foundations and process drains are commonly the most likely locations to encounter E&E constituents. Therefore, it is very important to carefully expose and verify that these operations either have historically been removed and that, if present, do not contain E&E constituents. The following former manufacturing units have been identified to possess the greatest potential for encountering E&E constituents and should be evaluated for the presence of former foundations and subsurface process drain pipes:

- New Nitrator
- Old Nitrator
- Neutralizer House
- NG Storehouse
- Acid Pond
- Mix House

- Nitro Cotton House

It should also be noted that E&E constituents found at the above listed operations have the potential to be confined (i.e. within a drainpipe) and can result in detonation of the constituents, if handled improperly. The following procedures are recommended to verify that the above listed operations do not possess E&E constituents:

Former Process Foundations

Former process foundations, if any, should be exposed and removed with heavy equipment (i.e. track excavator) equipped with a blast shield. The following activities should be conducted to safely expose and remove the process drainpipe:

- The ground surface should be tested using the EXPRAY[™] or ETK[™] E&E test kit. Testing should be conducted prior to initiating any ground surface penetration. Continued testing should be conducted as needed based on visual evidence or historic process knowledge for the presence of E&E.
- Two trenches should be excavated to a depth that native soils are encountered at the suspected location for each of the above listed operations. The trenches should be perpendicular to one another and form an X-like pattern over the suspected location of the former operation.
- If significant earthen barricade is encountered (Old Nitrator, Neutralizer House, and Mix House), the earthen material should be removed prior to excavating the two trenches. It is often best to begin at the most assessable side of the earthen barricade and carefully remove the soils and stage them immediately adjacent to the excavation area.
- If a foundation is encountered, the soils overlaying the foundation should be removed and a trench should be dug completely around the footprint of the foundation to uncover any drains leaving the foundation. The trench should

extend approximately one to two feet below the depth of the foundation to ensure that if any drainpipes were present they would be identified.

- Once the foundation, if any, has been determined not to contain any drainpipes, the excavator should carefully remove the foundation beginning at the corners and progressing toward the center. Foundations should not be removed until all drainpipes have been removed.

Careful observation and frequent E&E testing should be conducted by individuals experienced in former E&E manufacturing structure dismantlement throughout the foundation identification and removal process. E&E testing should be performed on all surfaces that have had the potential to contact E&E constituents.

Subsurface Process Drains

Process drainpipes, if any, should be exposed and removed using a combination of heavy equipment (i.e. track excavator) and manual labor following the process foundation identification and removal process but in the prior section we said to remove foundations after drain pipes are removed. The heavy equipment should be equipped with a blast shield. Hand equipment should be constructed of non-sparking materials (i.e. nickel/copper alloy). Every attempt should be made to expose the drainpipe at areas where the depth of the drainpipe is known. The following activities should be conducted to safely expose and remove the process drainpipe:

- The ground surface should be tested using the EXPRAY™ or ETK™ E&E test kit. Testing should be conducted prior to initiating any ground surface penetration. Continued testing should be conducted as needed based on visual evidence or historic process knowledge for the presence of E&E with a minimum required testing for each 2 feet of subsurface penetration and 100 feet of lateral excavation.

- At locations where the depth to drainpipe is known, the excavator should remove the overburden to within 6-inches of the pipe. A non-sparking shovel should be used to determine the remaining depth to the drainpipe confirming the overburden removal is complete. Once the overburden has been removed to within 6-inches, the remainder should be removed by hand.
- At locations where the depth to the drainpipe is not known, the excavator should remove overburden at 6-inch intervals. Following the removal of each interval a non-sparking shovel should be used to determine the location of the pipe or clear the excavator to remove the next 6-inch interval of overburden. This process should continue until the pipe depth has been confirmed. Once the overburden has been removed to within 6-inches, the remainder should be removed by hand.
- After the depth to the drainpipe has been confirmed, lateral exposure can be performed. Lateral exposure should involve slowly removing the overburden to within 6-inches of the drainpipe with the excavator. Once the overburden has been removed to within 6-inches, of the drainpipe the remainder should be removed by hand.
- Following exposure of any identified drainpipe, the interior should be thoroughly examined and frequently tested with the E&E test kit. If no E&E constituents are identified the drainpipe should be removed.

Note: In the event E&E constituents are located, all work will stop until a suitable method of destruction or disposal can be established. No E&E material will be accumulated until all BATF regulations have been satisfied.

4.7.7 Performing Sympathetic Detonation Program

Following the completion of exposing and removing potential process foundations and process drainpipes, a sympathetic detonation program should be conducted at the following locations that have the potential to historically released NG to the environment:

- New Nitrator
- Old Nitrator
- Neutralizer House
- NG Storehouse
- Acid Pond
- Mix House

The sympathetic detonation program will only be designed for NG related areas because, of the known E&E constituents used at the facility, NG is the only constituent exhibiting the sensitivity to be effected by sympathetic detonation. It is very important not to perform the sympathetic detonation program prior to removing any potential process foundations and drainpipes as NG may possibly be present in these features and dangerous larger than anticipated detonations might occur. The following procedures should be used to implement the sympathetic detonation program:

- A local blasting company should be contracted to provide the explosives and assist with the design of the sympathetic detonation program.
- The selected explosive should detonate as cleanly as possible and not negatively impact the environment.
- Each location should be subjected to either one or multiple surface or near surface detonations with sufficient energy to detonate residual NG to the maximum depth possible while not disturbing adjacent landowners.
- Following placement of the sympathetic detonation charges, all personnel on-site should be accounted for and positioned as far away from the blast area as possible in the command center. It is recommended to be within visual sight, use of binoculars is highly recommended to increase distance from the blast area, and protected by an earthen barricade.

- Once all personnel are accounted for and it is certain no other personnel have entered the facility, the explosive charges should be detonated.
- Following detonation, the area should be monitored from the command center for a minimum period of ½ hour before attempting to inspect the blast area.
- It is recommended to work closely with local authorities (i.e. police, fire, and municipal) to ensure smooth operation of the sympathetic detonation program.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following items present the conclusions and recommendations for the EHA:

- The health and safety of field personnel can be effectively addressed with adequate awareness training, appropriate procedures, and detailed attention to safety by field personnel. Field personnel must be prepared to identify E&E constituents and respond appropriately if encountered. All intrusive site investigation activities should be conducted as if E&E constituents can be encountered at any time.
- The EXPRAY[™] and ETK[™] colorimetric test kits are valuable screening tools essential for health and safety determinations but do not provide sufficient information for use as an environmental investigative procedure.
- TNT, AP, and sodium perchlorate were used as ingredients during the operational history of the Site. TNT analysis by SW-846-8330 and AP/sodium perchlorate analysis by EPA 314.0 should be included in the suite of analysis performed on the samples collected from the former Mix House and any identified AP/sodium perchlorate storage areas.
- E&E constituents are typically found in close proximity to the former manufacturing structure utilizing the constituent or in areas intentionally placed (i.e. ABS landfill). Sampling efforts should be focused to the location of the former structures handling E&E constituents and areas known to have had them intentionally placed.
- The Acid Pond received sour water from the old nitrator from an unknown number of years but may have been operational from 1932 to 1967. Sour water has the potential to contain up to 500 parts per million NG depending on pH of the sour water. While NG readily degrades in the environment, conditions may exist that prevent the degradation. Significant care must be taken evaluating the Acid Pond. Test pit methods with significant colorimetric testing are often employed for this type of evaluation.
- In event process foundations are encountered, the perimeter of the foundation should be excavated to a depth below the base of the foundation to determine if process drains exist. No process foundation should be removed until the determination that no process drains exist is satisfactorily completed.
- If confined E&E constituents are encountered or suspected to be present (i.e. process foundations and drainpipes) additional planning is required to safely remove the E&E constituents.
- A focused sympathetic detonation program, detonating small charges in areas with the potential to contain highly sensitive explosives (NG), should be conducted in select areas of the dynamite production area. However, this must

not be performed until sufficient attempts have been made to ensure no process foundations and/or drains that can potentially contain significant quantities of NG remain within the area of the focused sympathetic detonation area. The sympathetic detonation program should only be conducted at the following former operations:

- New Nitrator
 - Old Nitrator
 - Neutralizer House
 - NG Storehouse
 - Acid Pond
 - Mix House
-
- Evaluate the existing structures within the Powder Plant for residual explosive contamination. Dust generated during the manufacture of ANFO and slurry explosives may have accumulated on the upper surfaces of the structures. It is important to note that if perchlorate based energetic constituents are believed to possibly be present the ETK TM kit must be used as it has the ability to identify perchlorate constituents. If E&E constituents are observed the structures should be thoroughly cleaned with high-pressure water until colorimetric tests indicate no presence of E&E constituents.
 - Continue to make additional efforts to collect and evaluate as much information concerning the Site history as possible.

APPENDIX C, ATTACHEMENT A

Site Inspection Photographs

This attachment to the EHA contains photographs obtained by MWH Americas, Inc. during a site inspection at the former Pacific Powder site on November 20, 2003. The photographs are referenced throughout the EHA and are provided in electronic format in the enclosed CD for this Agency review copy of the Work Plan. The final RI/FS Work Plan will include hard copies of each photograph to facilitate the public review process.

EXPRAY Use and Application

EXPRAY is a field test kit designed to detect and identify trace levels of explosives and explosive residues. The kits have been extensively used in forensic investigations since 1991, and have been invaluable in their expedition of the apprehension of criminals. In the forensic, and, more recently, environmental capacities in which the kit has been utilized, it has proven to be the perfect combination of quick results (less than one minute per test), sensitivity (nanogram level), reliability, ease of transport (under two pounds), ease of operation (no special training and no power requirements), and inexpensive price (less than \$3 per test) to accommodate specific detection needs.

EXPRAY can be used to supply valuable qualitative information during environmental, criminal and forensic investigations. Listed below is a sampling of applications:

- Use to determine if process equipment or a surface has been in contact with explosives
- Certify scrap for disposal
- Soil sample screening
- Prescreen extracts for immunoassay analysis to determine if an explosive is present and if so identify which test (TNT or RDX) should be performed.
- Supplementary tool for detection of explosive devices or residues
- Use to screen for the presence of explosive materials in suspicious letters or packages
- Disclosure of chemicals contained in explosive devices, facilitating linking of previously collected evidence
- Disclosure of category of explosive used, enabling bomb teams to follow proper disposal or disarmament protocols
- Sweep crime scenes
- Allows for fast screening of suspects in the field, without interfering with other forensic tests.
- Kit sensitivity allows detection on almost any surface.

Through a series of sequential reactions, EXPRAY distinguishes between 1) polynitroaromatics, 2) nitrate esters and nitramines, and 3) inorganic nitrate compounds. Based on a patented procedure, this aerosol kit identifies these classes of compounds accurately, quickly, and distinctively. Refer to Tables 1 and 2 for a partial list of explosive compounds and mixtures detected.

The collector papers are laminated on one side and covered with a thin layer of glue on the other side to ensure good collection of specimen.

EXPRAY can be used as an investigative aid to distinguish between an explosive and non-explosive material. Through two or three very simple consecutive tests the kit will provide visual evidence of traces of the explosives listed below. The traces can be found on any surface suspected to have been in contact with explosives.

What does each can test for?

Expray-1 – Group A (Nitroaromatics) - Letter 'E' on the front. This type of explosives includes TNT, Tetryl, TNB, DNT, picric acid and its salts.

Expray-2 – Group B (Nitrate esters and nitramines) - Letter 'X' on the front. This type of explosives includes Dynamite, Nitroglycerine, RDX, PETN, Semtex, Nitrocellulose, smokeless powder, and Tetryl. NOTE: Most plastic types of explosives belong to this group.

Expray-3 – Group I (Inorganic nitrates) - Letter 'I' on the front. The nitrates based explosives include ANFO (ammonium nitrate-fuel oil), commercial and improvised explosives based on inorganic nitrates, black powder, flash powder, gun powder, potassium nitrate, and ammonium nitrate.

How do I use the EXPRAY kit?

Most explosives are not water-soluble and traces can be found months and years after the explosives have been removed. Directions are also printed on each can and inside cover of the Expray kit carrying case.

1. Wipe suspected surface with special collector test paper. (A small amount of soil or extract can be placed on the collection paper.)
2. Spray test paper briefly with Expray-1. If a dark brown-violet color (similar to the color of the label) appears this indicates the presence of TNT; an orange color indicates the presence of Tetryl and other GROUP A explosives.
3. If after spraying with the Expray-1 there is no color reaction, then spray the same test paper with Expray-2.
4. The almost immediate appearance of a pink color change (similar to the color of the 'X' letter on the label) indicates the presence of GROUP B explosives. Most plastic types of explosives belong to this group, including Semtex. [Tetryl belongs to both Groups, so it will change from orange (color change caused by EXPRAY-1) to pink after being sprayed with EXPRAY-2.]
5. If there is still no reaction after using the Expray cans 1 and 2, but presence of explosives is still suspected, spray the same paper with Expray-3. A pink reaction indicates the presence of nitrates, which could be part of an improvised explosive.

How can I be sure the kit is working properly?

The kit is equipped with verification papers that allow the technician to verify that the kit is working. To test the reagents, simply spray one of the EXPRAY cans on unused verification papers. If the letters EX come up, then the reagents are still good.

Do I have to use the collection papers?

No, the collection papers are provided as a convenient way to collect samples. Any clean white paper can be used. Although not recommended the spray can be used on any surface that contrasts with the developed color.

How sensitive is the kit?

Laboratory tests found the kit can detect particles as small as 20 nanograms. Such small particles can be found on hands, on working surfaces (tables, desk) and on the outer side of envelopes or parcels in which explosives were sent. Even after an explosion, unexploded particles can be found in the area, which can give an immediate clue about the nature of the explosion.

For detection of plastic explosives only, can "EXPRAY-2" be used without "EXPRAY-1"?

No, the reagents must be used sequentially in order to ensure accurate results.

How long after handling the explosive can traces be found?

Most explosives are not water soluble, and it is very hard to get rid of traces on the hands even after washing with water and soap. Explosive traces can be found on undisturbed objects even months and years after the actual explosive has been removed.

Is the result of the testing with EXPRAY accepted as evidence in court?

No, in order to gain evidence for court, further laboratory examination of the material is necessary.

If so, why use the kit?

Without a field kit, the technician performing an investigation cannot know which object should be sent for laboratory examination. The result is usually flooding the laboratory with numerous samples suspected of having explosive contamination, resulting in heightened possibility for error as well as increased time of testing. By using the kit, the technician can screen several samples/objects and send to the laboratory only those that give a positive result with EXPRAY, thus saving time and money in the laboratory.

Note: Some propellants and explosives are mixed with plasticizers (such as Bis(2-ethylhexyl)phthalate) that can mask the presence of some of the compounds, a solvent may be necessary in these circumstances to properly expose the energetic material and allow detection.

CHEMISTRY PRINCIPLES OF THE EXPRAY KIT

Nitroaromatics such as TNT, TNB, picric acid and its derivatives form highly colored compounds (Meisenheimer Complexes) upon reaction with alkali. Common alkali formulations for explosive analysis contain 5 to 10 percent tetrabutylammonium hydroxide in ethanol or water.

Nitrate esters such as nitroglycerine (NG), EGNG, PETN, and nitrocellulose (NC) under similar conditions will undergo alkaline hydrolysis producing nitrate ions (NO_2^-), which can be readily detected with the Griess reaction. This includes the action of nitrate ions on an aromatic amine, usually sulfanilic acid, in an acidic medium. The diazonium ion that is then formed is complexed with an aromatic nucleophile to produce a colored azo dye.

Nitramines such as RDX, HMX, and tetryl also undergo alkaline cleavage to form nitrate ions, which produce the same colored azo compound by the Griess reaction. Dimethyl sulfoxide (DMSO) is used as a solvent for the alkaline reagent. This solvent accelerates the color formation with plastic explosives. A combination of sulfanilamide and N-(1-naphthyl) ethylenediamine gives a fast and intensified color reaction.

As for the inorganic nitrates, a fine zinc dust is used to reduce them to nitrite ions that then react with the Griess reagent.

NOTES

There is no way of distinguishing between innocent fertilizers and nitrate-based explosives, so care should be taken when interpreting the results.

The spraying order must not be altered and all three sprays should be used when testing, in order to perform a complete test. If Expray-2 is sprayed after a positive result was obtained with Expray-1, a change to pink color is an indication of a double base or a triple base explosive (such as Composition B and triple base gunpowder). Even when Group B explosives only are tested, one should start with EXPRAY-1 and only then spray with EXPRAY-2. If nitrate based explosives are suspected, one should still start with EXPRAY-1, then move to EXPRAY-2 and only then apply EXPRAY-3.

Stability and Storage

All three reagents have been tested after accelerated aging experiment (50°C, 8 weeks). However, it is recommended that when not in use, that the cans should be stored a cool, dry place. The cans should always be stored in an upright position, and the carrying case of the EXPRAY kit should be stored in standing position. The cans are guaranteed for one year after purchase. However, the reagents should remain effective almost indefinitely.

False positives:

Any fertilizer containing nitrates will react to EXPRAY-3 (after 'E' and 'X'). If nitrite compounds (such as sodium nitrite) are tested, a color reaction will be obtained even after applying EXPRAY-1 and EXPRAY-2. No other false positives are known, but one should note that only the colors listed should be observed.

If a different color appears in any stage, it should be disregarded. Furthermore, an unreacted test paper left in the open-air will gradually change in color to light pink. Note that there are some varnishes and lacquers made of nitrocellulose (which is a group B explosive), and if the kit is applied directly to a surface treated with such coatings, a positive (pink) reaction will appear. The varnishes do not disperse residues, so that touching a varnished surface will not cause positive reaction on the touching hand or surface.

Health and Safety

In general, all spray products should be treated carefully. Do not: puncture the can, throw into fire, or expose to extreme heat.

Spray can should be held in upright position, and exposure to direct sunlight (especially in a parked car in the summer) should be avoided. Usually it is recommended to use the sprays in a ventilated area and to avoid inhalation of the spray. Do not smoke while spraying, as the propellant is flammable.

TABLE 1
COMPOUNDS DETECTED BY EXPRAY

Product:	EXPRAY - 1	EXPRAY - 2	EXPRAY - 3
Detects:	Polynitro-Aromatics	Nitrate-esters Nitramines	Inorganic Nitrate Compounds
Group:	Group A	Group B	Improvised

#	Substance	Color	Substance	Color	Substance	Color
1	TNT	Dark Brown	Semtex	Pink	Ammonium Nitrate	Pink
2	TNB	Dark Brown	RDX	Pink	Potassium Nitrate	Pink
3	DNT	Blue-Green	HMX	Pink	Sodium Nitrate	Pink
4	Picric Acid	Yellow	PETN	Pink	Barium Nitrate	Pink
5	Tri Nitro Napthalene	Violet	EGDN	Pink	Black Powder	Pink
6	Lead Styphnate	Yellow	Nitroglycerine	Pink	Strontium Nitrate	Pink
7	Tetryl	Orange	Tetryl	Pink	Silver Nitrate	Pink
8	Ammonium Picrate	Yellow	Nitrocellulose	Pink		
9	Nitroxylenes	Brown	Smokeless Powder	Pink		
10	DDNP	Orange-Brown	Haleite	Pink		
11			Nitroguanidine	Pink		
12			DEGN	Pink		
13			EDDN	Pink		
14			BTN	Pink		

TABLE 2
CROSS REFERENCE TABLE FOR TRADE NAMES OF EXPLOSIVES DETECTED BY
EXPRAY

#	Name of Explosive	Composition	Detected by Expray Can
1	Amatol	Ammonium Nitrate + TNT	1, 3
2	Ammonal	Ammonium Nitrate + TNT + Aluminum Powder	1, 3
3	Ammongelite		1, 2
4	Ammonium Perchlorate		Not Detected
5	ANFO	Ammonium Nitrate + Fuel Oil	3
6	C3	TNT + DNT + RDX + NC + Tetryl	1, 2
7	C4	RDX	2
8	Composition B	RDX + TNT	1, 2
9	Cordite	NC + NG	2
10	Cyclonite	RDX	2
11	Demolux	RDX + EGDN	2
12	Dynamite	Nitroglycerin	2
13	Gelanite	Nitrocellulose + Nitroglycerin	2
14	Gun Cotton	Nitrocellulose	2
15	HBX, H6	RDX + TNT	1, 2
16	Lead Azide		Not Detected
17	Mercury Fulminate		Not Detected
18	Octogen	HMX	2
19	Octol	HMX + TNT	1, 2
20	Pentolite	TNT + PETN	1, 2
21	Pentrite	PETN	2
22	Picratol	TNT + Picric Acid	1
23	Semtex H	RDX + PETN	2
24	Tetrytol	Tetryl + TNT	1, 2
25	Torpex	TNT + RDX + Aluminum Powder	1, 2
26	Tritonal	TNT + Aluminum Powder	1
27	Water Gel	Ammonium Nitrate + Magnesium	3

Price List

Explosive Detection & Identification Sprays

M1553	Expray Kit	Size / Quantity	Kit Price
Includes: Used as per instructions, kit yields 100 tests minimum.	Expray #1	100 ml	
	Expray #2	100 ml	
	Expray #3	60 ml	
	Collection Papers (M0530)	50 each	
	Collection Papers (M0530)	50 each	
	Verification Papers	10 Each	
	Large Carrying Case (MR1)	Tan	
			\$236.40

Price is effective 2001. Inquire concerning quantity discounts. Prices subject to change without notice. Additional shipping charges apply.

EXPLOSIVES DETECTION KIT ETK

NSN : 1385-14-517-9412

ETK enables simple, rapid and reliable detection of persons engaged in preparing, handling or carrying explosive charges, and allows for fast screening of suspects in the field. The kit aids in detection, through exposure and proof of contact contamination of various surfaces, by explosives.

The ETK distinguishes between explosive and non-explosive materials. Furthermore, is capable of identifying four classes comprising the majority of explosives currently in use, and revealing their traces on the body and various items such as clothes, suitcases, door handles and car surfaces.



Simplicity

ETK's simple design and mode of operation specifically developed for ease of handling, can be operated after only a few minutes of easily followed instructions.

Safety

The ETK is extremely safe for both operator and suspect, as there is no direct contact with the chemical components used in the test. All of the test reagents are contained within glass ampoules in specially designed protective plastic tubes. The test is performed by applying a few drops of reagents on absorbing paper (no spraying of chemicals).

Range of identification

The ETK is capable of identifying the full range of well known types of military and commercially available explosives, and also of homemade explosives based on nitrate and chlorate salts.

The ETK provides classification of the detected explosives into 4 main groups :

- A. Polynitro aromatics
- B. Nitrate esters and nitramines
- C. Nitrate salts
- D. Chlorates



No interference with most other Forensic tests

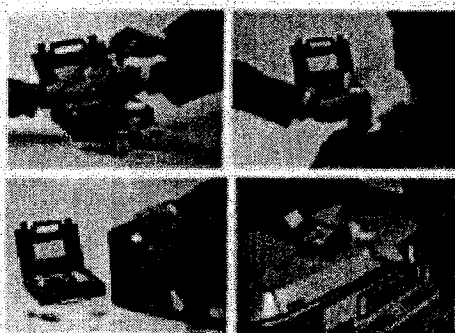
By use of dry sampling and spot tests on samples, most other crime tests, such as fingerprinting of suspects, can be done after the sampling.

Rapid results

The test takes a few seconds, from the time of sampling until final results are obtained, enabling quick screening of large numbers of suspects.

Unequivocal results

Test results, in case of positive identification, are characterized by the appearance of intense colors clearly visible on the test paper.



TECHNICAL DATA

Test sensitivities

- Group A : TNT, Tetryl, TNB, Picric acid and its salts = 0,1 - 1 µg
- Group B : Dynamite, RDX, PETN, Nitrocellulose smokeless powder and plastic explosives such as C4 and SEMTEX = 0,01 - 0,1 µg
- Group C : Nitrate salts = 0,01 µg
- Group D : Chlorates = 10 µg